LABORATORY EQUIPMENT AND METHOD FOR MAKING NEP TESTS ON COTTON SAMPLES

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Agricultural Marketing Service
Cotton Division
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CONTENTS

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The research and development work upon which this report is based was planned and conducted under the direction of John W. Wright, Chief, Standards and Testing Branch, Cotton Division. Appreciation is expressed to Samuel T. Burley, Jr., for technical assistance and to the staff of the Washington fiber laboratory for testing assistance.

SUMMARY

The entire cotton industry has increasingly recognized the usefulness of laboratory test methods for measuring the physical properties and manufacturing qualities of cotton fibers, and this recognition has emphasized the need for a rapid method of preparing and evaluating raw cotton with respect to neps. Three methods of preparing fiber specimens for mounting on black-velvet-covered boards for counting of neps are generally used in making nep evaluations, as follows:

1. Specimens taken from card web produced in a commercial cotton mill during processing.

2. Specimens taken from the card web produced in a spinning laboratory when testing small lots of cotton.

3. Specimens prepared manually by manipulating small pinches of cotton to provide relatively thin webs of fiber.

The first method enumerated has the disadvantage of having the stock already processed through the card before nep evaluation of the cotton can be made. The second method is applied only to testing laboratories having the facilities for conducting spinning tests. The third method has proved unsatisfactory from the standpoints of the accuracy of the reproducibility of the results, accuracy of predicting processing behavior, and the excessive amount of time required to perform such laborious tests.

To provide a rapid and satisfactory method of preparing specimens of raw cotton for nep evaluation, a laboratory-type machine has been devised to produce a relatively narrow web of fibers from a small sample of cotton. The design of this machine incorporates the principal mechanical assemblies of textile carding machines in order to simulate commercial production methods as closely as possible. The machine will process a 3-gram sample of blended cotton to produce a continuous web 4 inches wide and approximately equivalent in appearance and weight to card web produced for 40-grain sliver. Sufficient web is produced to provide 10 specimens which are placed on 4 x 9-inch boards for nep evaluation.

The nep test machine is a compact laboratory-type apparatus which is motor-driven and simulates the functions of a commercial carding machine except for the action of the licker-in. Its mechanism consists of a feed roll, a feed plate, a carding cylinder, a carding flat, a doffing cylinder, and a doffing comb. The carding cylinder, the carding flat and the doffing cylinder are covered with a straight wire and flexible foundation type of commercial card clothing. Provision has been made for stripping or cleaning the machine with either a vacuum cleaner or a hand card.

A series of tests was performed on the web delivered by the nep test machine for perfecting the method and evaluating the equipment for determining nep content. The specific objectives of these tests were:

1. To determine the accuracy of the reproducibility of the results of nep tests using the nep test machine.

2. To determine the correlation between ginned lint evaluations of neps in nep machine web and spinning test evaluations of neps in card web and between each of these evaluations of neps with carded yarn appearance.

3. To determine the comparative level of the nep test results obtained by using 2 units of the nep test machine.

As a result of the first series of tests, the procedure adopted for making raw stock nep tests includes the counting of the neps in ten 4 x 9-inch specimens of web by each of 2 technicians without the use of a template. The accuracy of the reproducibility of the results obtained when this procedure is used was calculated to be within a standard error of approximately 3 neps per 100 square inches of web. Two technicians employing this procedure can perform nep tests on an average of 4 samples per hour including the blending, the preparing of the specimens, the cleaning of the machine and the counting of the neps.

Analyses of the results for 498 samples of cotton indicate that the correlation between raw stock nep content and neps in card web is not sufficiently high to permit the use of a conversion formula for routinely reporting the nep test machine results as estimated neps per 100 square inches of card web. Comparative analyses, however, indicate that slightly more of the variance in carded yarn appearance is explained by ginned lint evaluations of neps in nep test machine web than is explained by spinning test evaluations of neps in card web.

A series of tests was performed on both the experimental model which was used in the evaluation of the method and the redesigned model which can be reproduced for routine tests in cotton testing laboratories. These tests indicate that the results obtained with the two models are on the same level for all practical purposes.

LABORATORY EQUIPMENT AND METHOD FOR MAKING NEP TESTS ON COTTON SAMPLES

By: Joseph T. Rouse, George E. Gaus, and Frances Carpenter
Cotton Technologists

INTRODUCTION

A desirable feature of any cotton is its relative freedom from neps, since they may be a source of trouble in manufacturing yarns and fabrics. The occuence of neps in appreciable numbers detracts from the appearance of those products. This is especially true when they are to be dyed or printed, because neps absorb dyes differently and appear as spots in the material. Neps are not found in unpicked cotton, but are found during the harvesting, ginning, and processing stages. It is a recognized fact, however, that some cottons have a greater tendency toward nep formation than others. 1/

Neps are fairly easy to detect and to count in specimens of card web taken during the processing of cotton on a commercial type carding machine when the web is placed on boards covered with black velvet. This method of evaluating cotton samples with respect to neps is employed routinely in connection with spinning tests in the laboratories of the Cotton Division of the Agricultural Marketing Service. Though it is also used extensively in cotton textile mills, it has a number of limitations and disadvantages.

The facilities and labor required to process test samples through commercial picking and carding machines prohibit the use of this method for routine tests except in cases where the cotton is being processed for other purposes. Also, a minimum of approximately five-pounds of cotton is required for such tests. And in the case of mill-run tests the cotton is processed through the card for manufacturing purposes before the evaluation is made.

A method for evaluating raw cotton with respect to neps employing a small sample and relatively simple equipment would be a valuable contribution in the field of cotton testing. Cotton laboratories could provide the facilities for such evaluation without prohibitive expenditures, and bale samples moving in marketing channels could be tested before the bales are opened at the mills. The results of such preliminary nep tests would be more useful than those obtained after the bales are opened and the cotton partially processed.

Various methods for counting neps in raw cotton which have been previously attempted in the Cotton Division laboratories, have proved unsatisfactory both from the standpoint of the reproducibility of the

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1/ Pearson, Norma L., "Neps in Cotton Yarns as Related to Variety Location and Season of Growth," USDA Technical Bulletin, No. 878 December 1944.

results and of predicting spinning behavior. Furthermore, time required for performing these tests makes them impractical.

The nep test machine on which the method covered by this report is based was designed to produce a thin web from a 3-gram sample of blended raw cotton. 2/ Only mechanically blended samples 3/ in which the fibers have been untangled should be processed on this machine. The web produced by the nep test machine is very similar to card web produced on a commercial type carding machine. However, the nep counts on web from this machine do not necessarily coincide with nep counts made on card web since processing through the card not only removes some neps from the cotton but also causes formation of other neps.

This machine has been designed to minimize the formation of neps so as to provide as nearly as is practicable an indication of the nep content of samples of raw cotton. Since it is practically impossible to do any processing of cotton without forming some neps, these nep counts actually reflect a combination of the nep content and the nepability of a sample of raw cotton.

The processing steps in the use of this equipment are as follows:

1. Feeding of blended raw stock to a cylinder covered with card clothing.
2. Stripping loose fibers and certain fiber imperfections from the surface of the layer of cotton embedded on this cylinder.
3. Transferring the layer of cotton to a second cylinder covered with wire card clothing.
4. Removing a continuous thin web of fibers from the second cylinder with a reciprocating fine-toothed bar comb.

Another laboratory-type machine for producing a sample cotton web for nep evaluation has been developed recently by the Department of Textile Research, School of Textiles, North Caroline State College. 4/ This machine uses several cylinders covered with metallic card clothing and a different method of processing the fibers.

Also a method of preparing a web on the USDA Mechanical Blender for nep evaluation has been published 5/ This method consists of (1) blending the test sample on the mechanical blender, (2) reducing the

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2/ Rouse, Joseph T., A Method of Determining the Nep Content of Ginned Lint by Using Accessory Equipment with the Mechanical Fiber Blender. Textile Research Journal, Vol. XXIV No. 6, June 1954

3/ Gaus, George E., and Larrison, John R., A Mechanical Cotton Fiber Blender for use in Fiber Testing Laboratories, 24 pp., Prod. and Marketing Adm., USDA - August, 1951.

4/ Bogdon, J. F. Measuring the Nepping Potential of Cotton. Textile Research Journal. 24 (6): 491-494. June 1954.

5/ Orcutt, Priscilla L., and Wakeham, Helmut, A Method of Preparing Bulk Cotton for Nep Counting. Vol. XXIII, September, 1953, No. 9, Textile Research Journal.

clearance between the feed mechanism and the wire cylinder of the blender, (3) running a number of portions of the sample bat through the feed mechanism to procure a series of thin web-like specimens of fibers on the blender cylinder and (4) removing the specimens of web from the blender cylinder for neps per unit weight determinations.

DESCRIPTION OF MACHINE

General Description

The action of the nep test machine is somewhat similar in principle to a carding machine used in cotton textile mills. The cleaning function as provided by the card licker-in, however, is omitted. Essentially, the nep test machine comprises in combination a feeding mechanism, a carding mechanism, a doffing mechanism, and driving mechanism, all mounted on a supporting framework. It is a compact portable machine powered by two small electric motors. The approximate over-all dimensions are 15-1/2 inches wide, 26 inches long, and 20-1/2 inches high (Figure 1).

Primarily, the feeding mechanism consists of a curved feed plate that is spring loaded to press against a fluted feed roll (Figure 2). The feed roll rotates slowly to provide a uniform rate of feed for a blended bat of cotton guided by the feed roll and feed plate onto the surface of the carding cylinder. An apron supports the cotton bat as it is fed by the feeding mechanism.

The carding mechanism consists of a carding cylinder and a carding flat covered with commercial card clothing or fillet. The fibers of the blended bat are picked up by the carding cylinder as they are released from the feeding mechanism. These fibers are then carded between the carding cylinder and the carding flat to untangle them and obtain uniform distribution on the carding cylinder.

The doffing mechanism consists of a doffing cylinder and a doffing comb. The doffing cylinder is covered with card clothing and is rotated in reverse direction and at a slower surface speed than that of the carding cylinder. The card clothing used on the carding cylinder, carding flat and doffing cylinder is a single pitch straight tooth (without a knee) wire clothing which is mounted in a resilient type foundation. The use of this type of clothing facilitates doffing and subsequent stripping of the cylinders.

The Driving Mechanism

The fluted feed roll of the feeding mechanism is driven directly by a 1/1000-horse power gear-reduction electric motor which develops 75 in. oz. torque output at 5.7 r.p.m. (Figure 3). The carding cylinder, doffing cylinder and doffing comb are driven by a system of roller chains and sprokets powered by a 1/12 H.P. gear-reduction reversible electric motor. This motor develops 24 in. lb. torque output at 172.5 r.p.m. A single 3/16-inch pitch duplex-type roller chain is used to drive the carding cylinder in one direction of rotation and the doffing cylinder in opposite direction simultaneously. Chains with 1/4-inch-pitch drive the oscillating mechanism of the doffing comb.

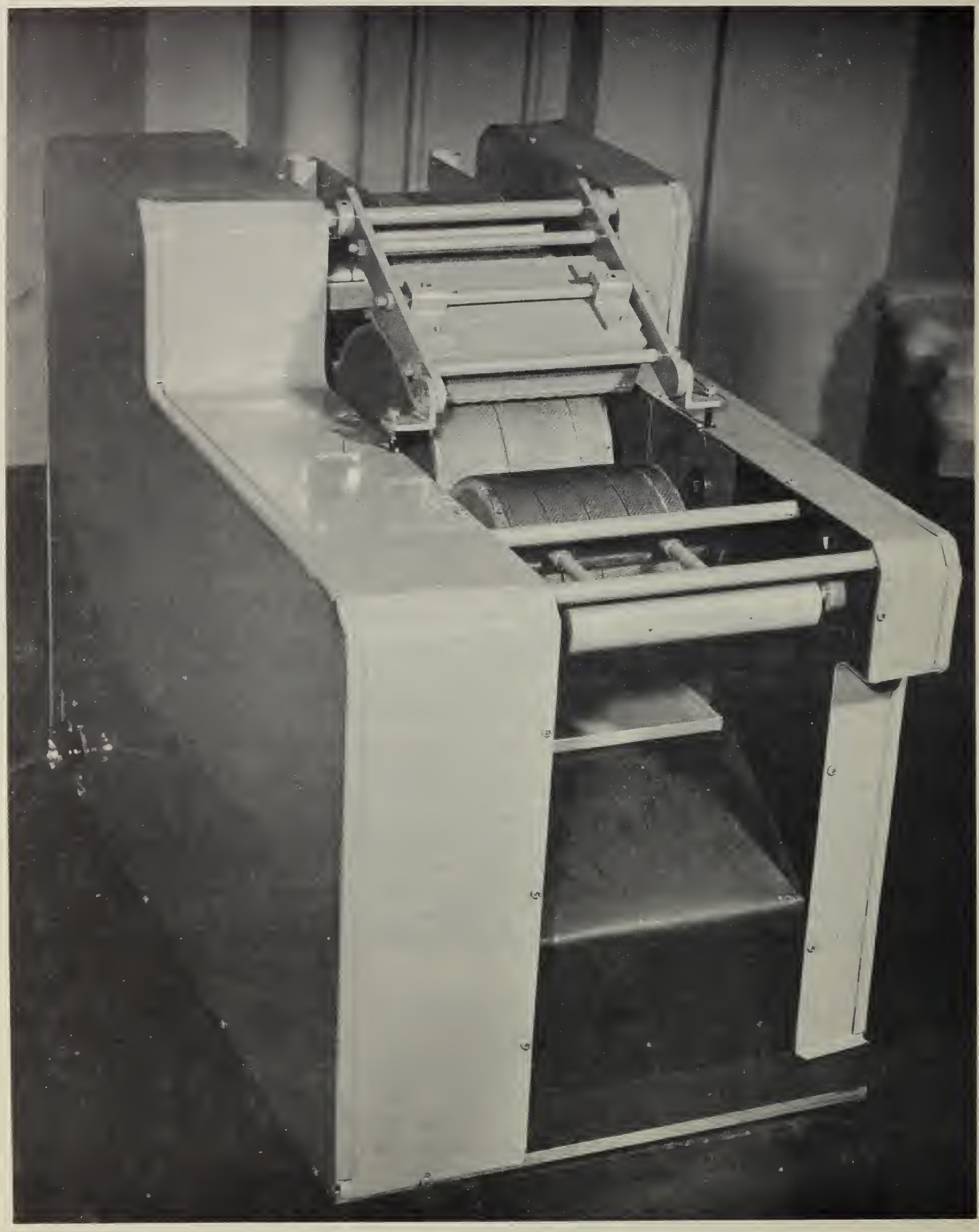

Figure 1. - The Nep Test Machine.

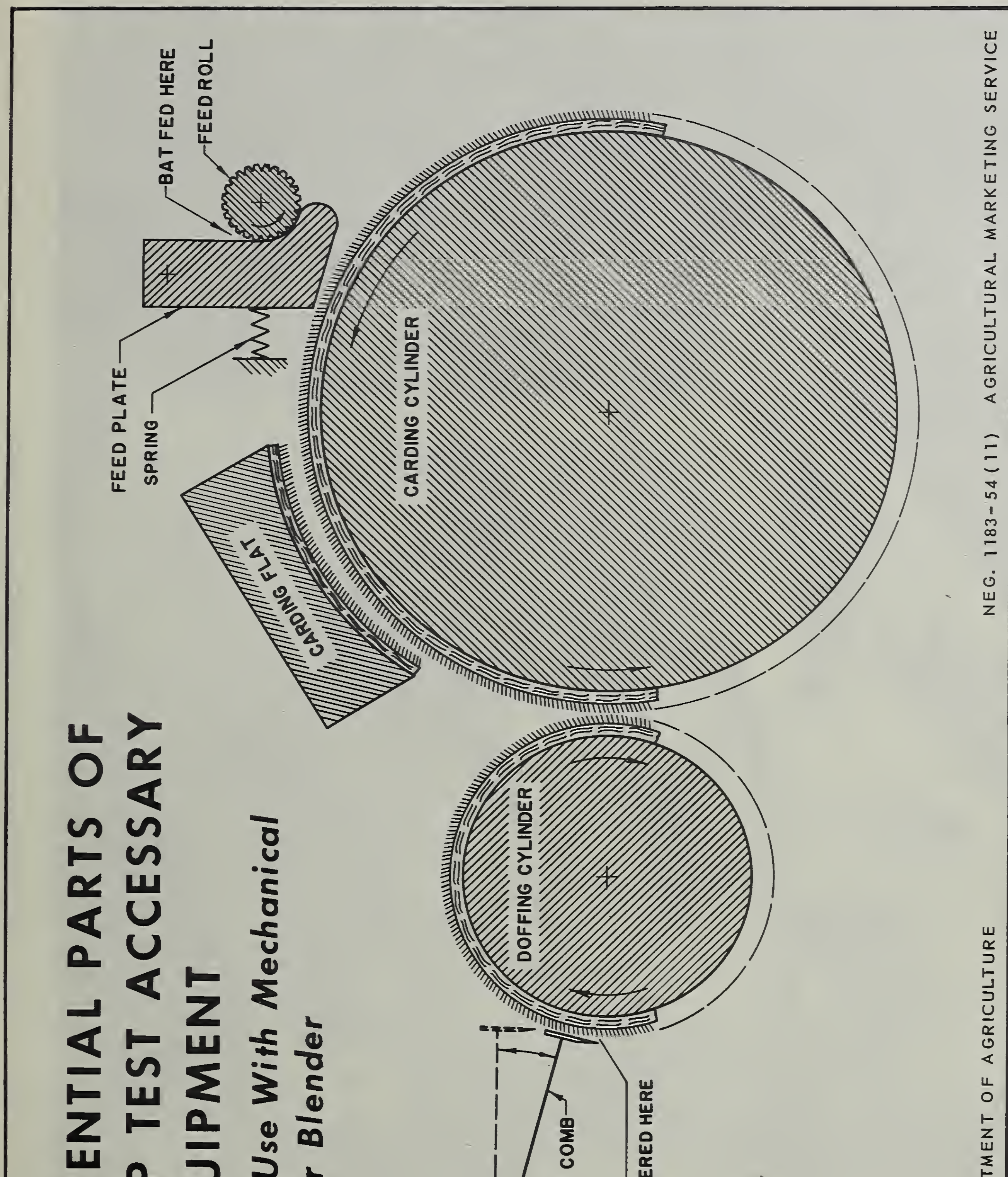
ESSENTIAL PARTS OF
NEP TEST ACCESSARY
EQUIPMENT
For Use With Mechanical
Fiber Blender
BAT FED HERE
FEED ROLL
FEED PLATE
SPRING
CARDING FLAT
CARDING CYLINDER
DOFFING CYLINDER
DOFFING COMB
WEB DELIVERED HERE
U. S. DEPARTMENT OF AGRICULTURE
NEG. 1183-54(11) AGRICULTURAL MARKETING SERVICE

Figure 2.

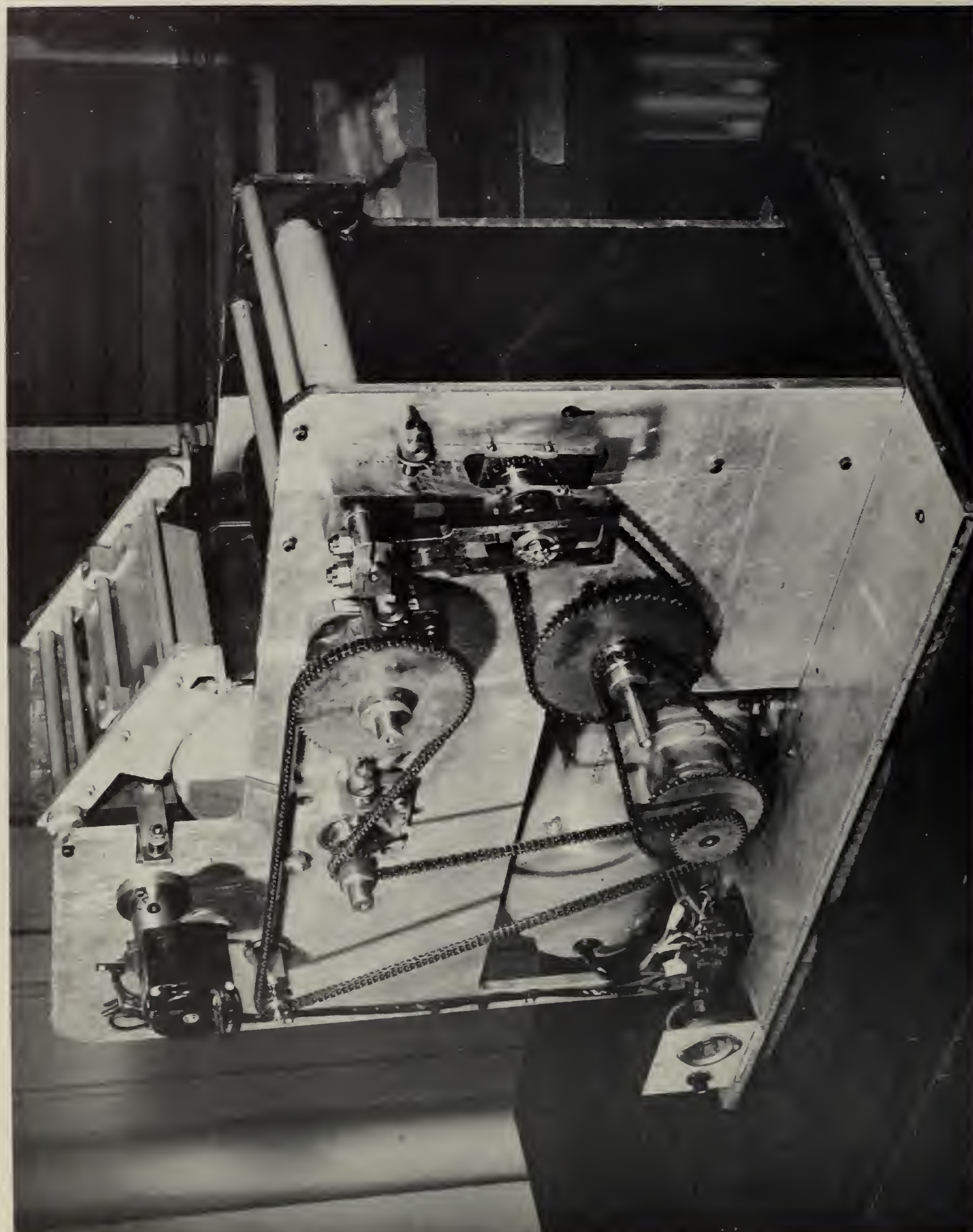

Figure 3. - View of nep test machine showing operating mechanism.

The two motors are controlled by a 3-pole double throw center-off position toggle switch. In its forward running position the switch operates both motors for processing the sample bat of cotton. In its reverse position, the switch operates the motor-drive for the two cylinders and doffing comb in reverse direction, and the feed mechanism motor is cut out of the circuit. This reversal of operation of the two cylinders is a desirable feature when the cylinders are cleaned. Having the feed mechanism motor inoperative while cleaning the cylinders prevents unnecessary wear of the feed roll and feed plate contacting surfaces.

The Framework

The framework of the machine consisting of a base and two vertical side pieces, is made of 3/8-inch aluminum plate (Figure 4). The vertical side plates are held in parallel alignment by tie rods. These side plates support all working parts of the machine with the exception of the 1/12 H.P. motor which is mounted on the base plate.

Sheet metal housing and shields are provided on the framework for safety of operation and to prevent lint and fly collecting on the driving mechanisms (Figure 5). A removable tray is located below the carding and doffing cylinders to collect any trash dislodged from the cotton fibers.

The Feed Mechanism

The feed mechanism is positioned near one end of the machine. Bronze bearings for the feed roll shaft are pressed into the side plates. The shaft of the feed roll is coupled to the shaft of the 1/1000 H.P. motor which is mounted on the right hand side plate, as viewed when facing the feed roll. The feed plate is attached to a suspension bar supported at each end by a stud mounted horizontally in a recess formed in each side plate. Each of these two studs supports a spiral compression spring arranged to exert varying pressure on the feed plate and to force the plate into contact with the feed roll. An apron with adjustable guide plates, and attached to the tie rods supports a cotton bat as it is being taken in by the feeding mechanism.

The Carding and Doffing Cylinders

The carding and doffing cylinders are mounted in line behind the feed plate (Figure 6). The shafts of these cylinders are carried by flanged cartridge ball bearings mounted on the side plates. These bearings are arranged for horizontal movement by means of fine thread screws to provide for adjustment of the clearance between the two cylinders and between the carding cylinder and the stationary feed plate. The carding and doffing cylinders are driven in opposite directions by a chain from the 1/12 H.P. motor through sprockets mounted on the right hand side of the cylinder shafts. Slots formed in the two side plates permit ready removal of the two cylinders when grinding or replacement of the card clothing is required.

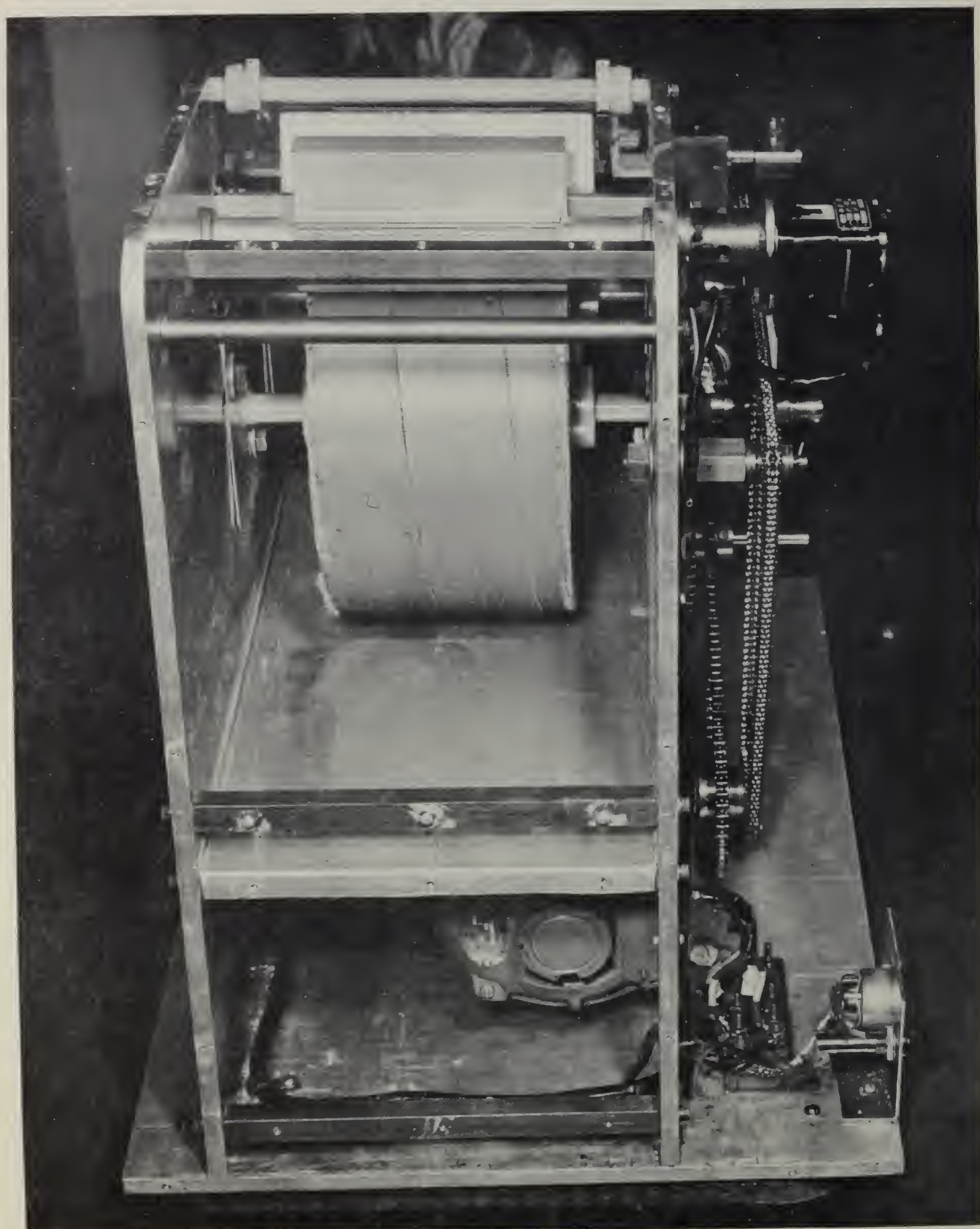

Figure 4. - View of nep test machine showing the framework (rear view).

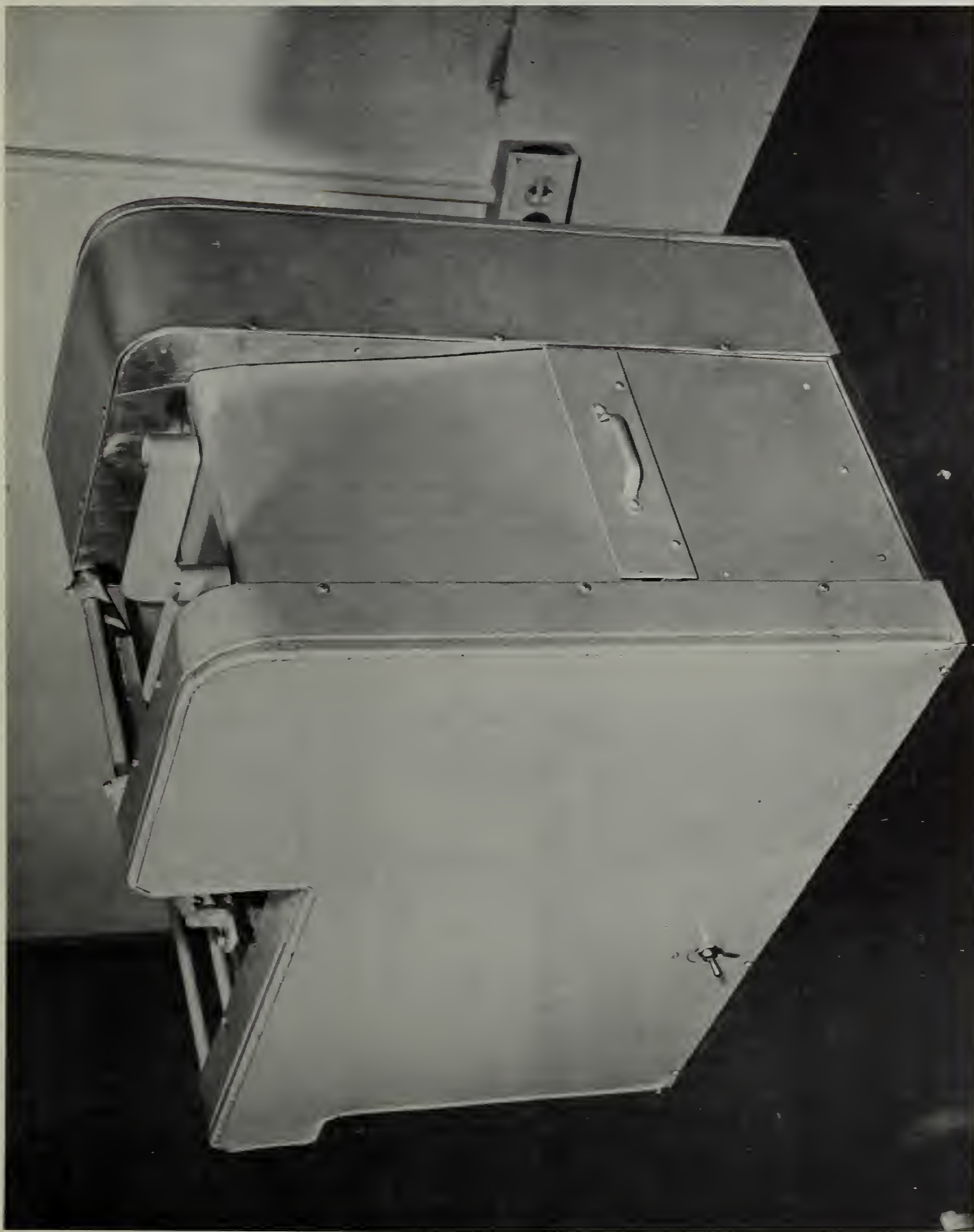

Figure 5. - View of nep test machine showing sheet metal covers and trash tray (rear view).

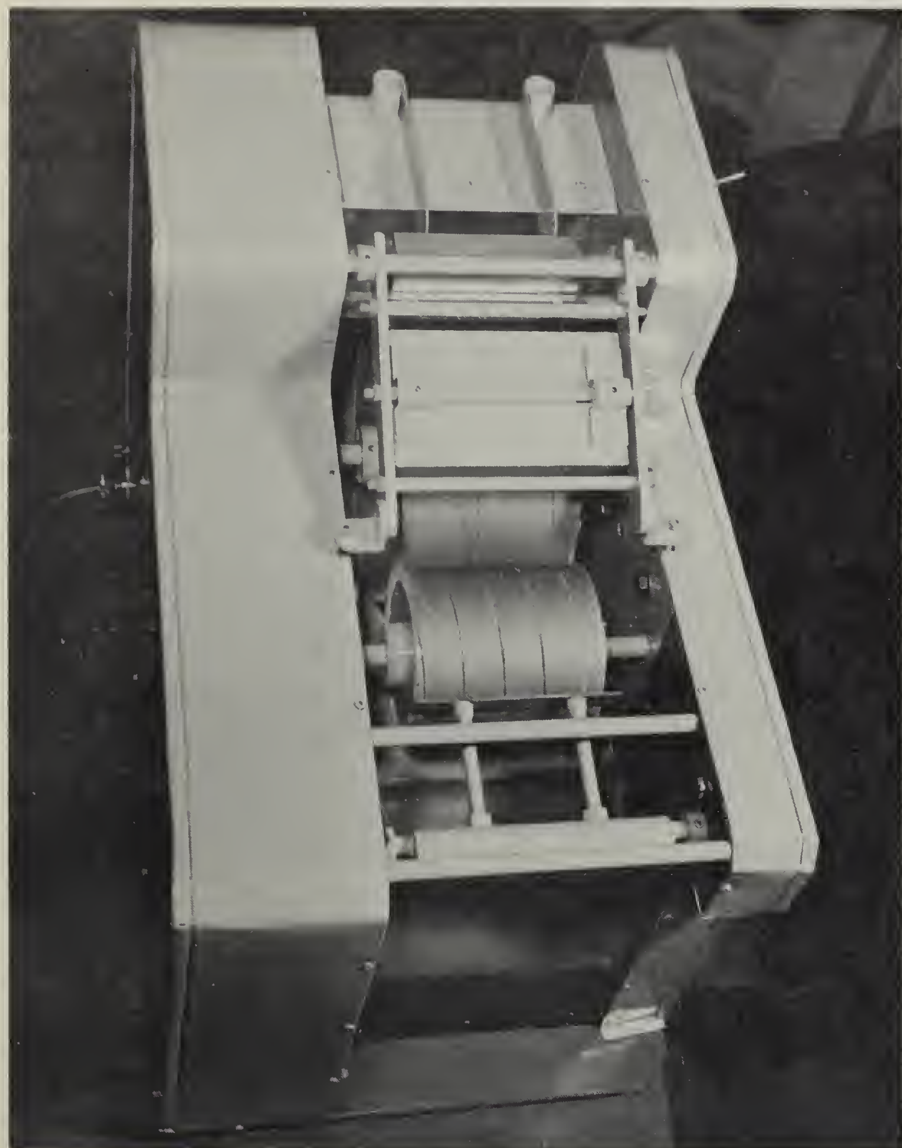

Figure 6. - View of nep test machine showing feed mechanism, carding flat, carding cylinder, doffing cylinder and doffing comb.

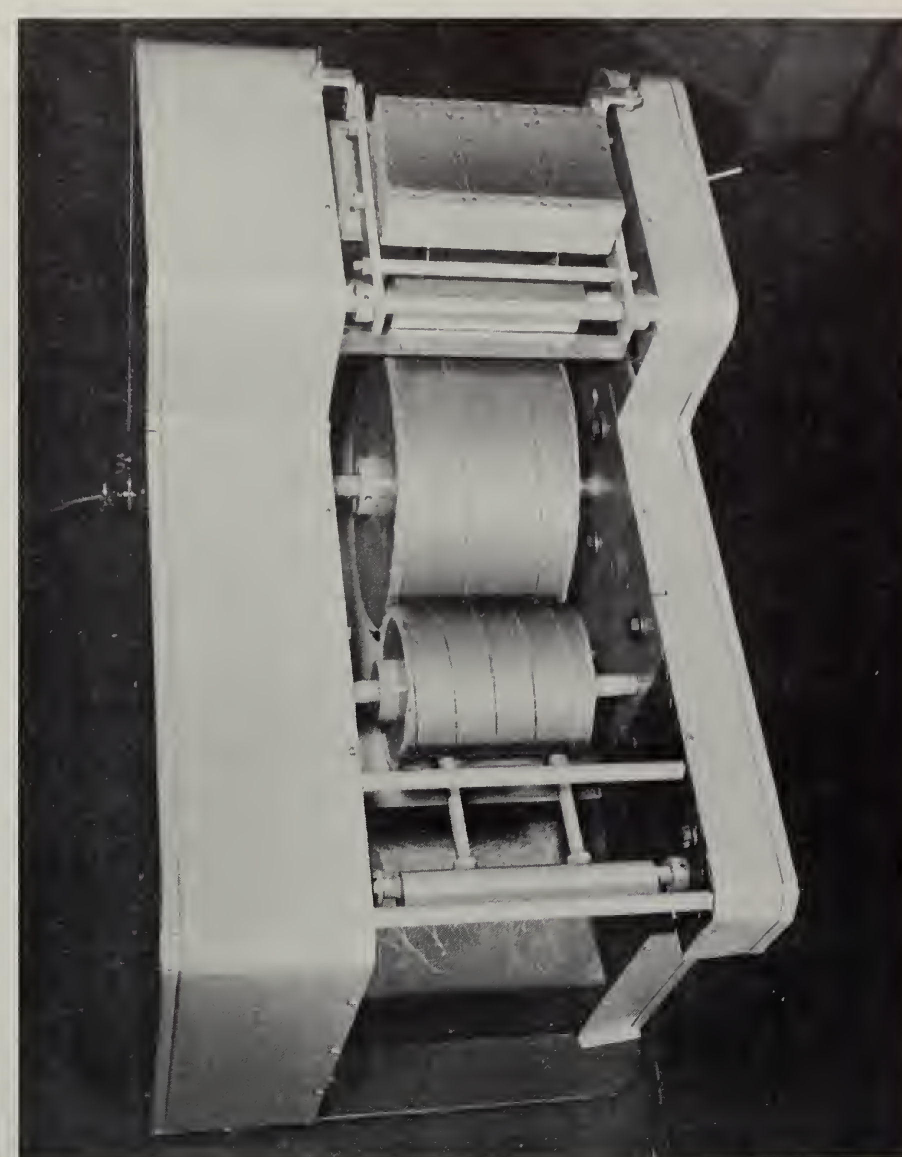

Figure 7. - View of nep test machine showing the carding flat swung away from the carding cylinder.

The Carding Flat

The carding flat assembly frame is pivotally mounted above the carding cylinder on a tie rod, and the assembly can be swung away from the cylinder to facilitate cleaning of both the carding cylinder and the carding flat. (Figure 7) Adjustable supports on the carding flat together with stop screws on the lower end of the assembly frame permit the flat to be moved in vertical angles for setting the front and rear clearance between the flat and the carding cylinder. The working surface of the flat is concave in conformity with the surface of the carding cylinder. The flat remains stationary during the operation of the machine.

The Doffing Comb Mechanism

The doffing comb mechanism consists of a roller cam operating a slotted lever which is clamped on one end of the comb shaft to impart alternating motion to the shaft. This comb shaft has attached a conventional carding comb bar which when reciprocated combs and removes a continuous web of cotton fibers from the doffing cylinder. The comb shaft is supported by bronze bearings mounted on the side plates of the machine. These bearings, one of which is integral with the housing for the roller cam and slotted lever, are arranged for horizontal movement by means of fine thread screws to provide for adjustment of clearance between the comb bar and doffing cylinder.

The arc of reciprocation, or stroke, of the comb bar is controlled by adjustments made of the throw of the roller cam. Adjusting and setting the travel, or sweep, of the doffer comb teeth below the horizontal center line of the doffing cylinder is accomplished by rocking the comb shaft in its fastening clamp on the slotted lever to the desired position, and then tightening the clamp.

A system of sprockets and roller chain mounted on the right hand side plate connecting the roller cam shaft with the 1/12 H.P. motor shaft serves to drive the doffing comb at the required number of oscillations per minute.

The fibers from the carding cylinder are condensed on the surface of the doffing cylinder. These fibers are then removed from the doffing cylinder in the form of a thin continuous web by the doffer comb which is oscillated at a relatively high rate of speed. As the web is removed by the doffing comb it is picked up by hand and sections of it are laid on boards covered with black velvet. The neps appearing in these sections of web are counted visually in accordance with accepted testing procedures.

The speeds, sizes, and settings of the various working parts are as follows:

Item	Speed (r.p.m.)	Diameter (inches)	Width (inches)
Feed roll	5.7	1-3/32	5
Carding cylinder	296.0	8-7/8	5
Doffing cylinder	84.0	4-3/8	5
Doffing comb	[redacted] 1318.0	oscillations per minute	5-1/2

	Settings (inches)
Feed plate to carding cylinder	.010
Carding cylinder to carding flat (top)	.0625
Carding cylinder to carding flat (bottom)	.010
Carding cylinder to doffing cylinder	.007
Doffing cylinder to doffing comb	.022
Stroke of doffing comb	7/8 in. (approx.)
Sweep of doffing comb teeth below horizontal center line of doffing cylinder	1/16 in.(approx.)

The 1/16-inch setting of the sweep of the doffing comb teeth below the center line of the doffing cylinder noted above, produces a web which is approximately equivalent to a 40-grain card sliver web. The weight of the web delivered, however, can be adjusted by changes made in this setting. Raising the comb increases the weight-per-yard of the web delivered and lowering the comb decreases the weight.

Operation of Machine

In operating the nep test machine, a 3-gram sample bat which has been previously blended three times on the USDA mechanical blender is fed to it. This sample bat is first laid out on a flat surface, and each edge is folded over slightly to make the width approximately 4 inches. Inasmuch as the length of the bat is the same as the circumference of the blender cylinder, this procedure insures that a constant weight per unit area is fed to the machine.

After the machine is started in the forward direction, one end of the blended bat is started by hand between the feed roll and feed plate allowing the bat to be supported by the feed apron. As soon as the web is delivered at the doffer comb, it is picked up by hand and a section is laid on a 4" x 9" board covered with black velvet as it is being delivered (Figure 8). Subsequent sections of the web are taken on covered boards in a similar manner until the desired number of specimens is available for nep counting. Each board is stored in a rack as the specimen is taken and the nep count is performed later.

After the processing of each sample, it is necessary to strip out the fibers that have become inbedded in the carding cylinder, doffing cylinder, and to clean the machine and carding flat. The carding and doffing cylinders are stripped or cleaned with a vacuum cleaner while the machine is in operation (Figure 9). The cylinders can also be cleaned with a hand card instead of the vacuum cleaner.

Figure 8. - View showing the method of extracting test specimens from the web as it is delivered by the nep test machine.

Figure 9. - View showing the method of cleaning or stripping the nep test machine.

EVALUATION OF EQUIPMENT AND METHODS

Nep Evaluation

Considerable difficulty arises in the counting process, since it is hard to distinguish between neps and other fiber imperfections found in cotton, and to classify neps according to size or importance. There are usually pieces of seed-coat fragments, motes, leaf, and trash of various kinds in addition to fiber tangles of various sizes in samples of raw cotton. Neps, however, are generally accepted as being entanglements of fiber clusters.

When counting them it is necessary to determine which type of fiber entanglement should be counted as a nep and which ignored. For the purpose of this study, a nep is determined to be a definite fiber tangle having a hard central knot or core sufficiently large to be visually detected. A selected specimen of web was used as a guide or standard in developing technician judgement and agreement. Some neps in this standard specimen of web were labeled examples of the smallest size to count and others were labeled examples of the largest size to ignore. These examples were selected to include "A" neps and larger as designated in nep standards of the American Society for Testing Materials 6/.

Nep content determinations on the web delivered by the nep test machine were made for four series of test samples to evaluate the equipment and perfect the method. Each of these series pertain to a specific phase of the evaluation as discussed in subsequent sections of the report.

Accuracy of Nep Test Results

The first series of tests was performed to determine whether the reproducibility of the results of nep counts would be better with or without the use of a template which has ten holes. Each hole exposes 1 square inch of web when superimposed on a 4 x 9-inch specimen. This series consisted of 5 replicates of each of 7 cottons for which the neps in each of 6 specimens of web were counted by each of two technicians, both with and without the use of a template.

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The nep counts on the samples in this series of tests indicate that the reproducibility of the results are better when counted without a template. The average range of the number of neps per 100 square inches of web between the 5 replications for the seven cottons was 14 when counted without the template as compared to 20 when counted with the template (Table 1).

6/ ASTM Standards on Textile Materials, American Society for Testing Materials, October, 1953.

Table 1.--Neps per 100 square inches of web prepared on the nep test machine when counted without and with the use of a template 1/.

Cotton and replication	Neps per 100 square inches of web counted: Without template	Neps per 100 square inches of web counted: With template	Cotton and replication	Neps per 100 square inches of web counted: Without template	Neps per 100 square inches of web counted: With template
Cotton # 1 (15/16 in.)-	Number	Number	Cotton # 5 (1-3/16 in.)-	Number	Number
1	24	34	1	30	36
2	20	29	2	30	44
3	17	24	3	24	32
4	20	24	4	33	34
5	20	22	5	28	38
Average	20	27	Average	29	37
Range	7	12	Range	9	12
Cotton #2 (1 inch)-			Cotton # 6 (1-1/4 in.)-		
1	13	18	1	51	60
2	13	18	2	64	68
3	14	21	3	56	66
4	15	12	4	70	64
5	13	13	5	62	64
Average	13	16	Average	61	64
Range	3	6	Range	19	8
Cotton # 3 (1-1/32 in.)			Cotton # 7 (1-1/2 in.)-		
1	20	24	1	21	26
2	23	32	2	28	38
3	25	29	3	26	19
4	28	24	4	31	29
5	18	16	5	26	19
Average	23	25	Average	26	26
Range	10	16	Range	10	19
Cotton # 4 (1-1/8 in.)					
1	114	130	All Cottons:		
2	84	94			
3	77	62	Av. No.	37	41
4	76	79	Av. range	14	20
5	78	84			
Average	86	90			
Range	38	68			

1/ Neps on 6 4x9-inch specimens were counted by each of 2 technicians. A total of 216 square inches were counted without the template and a total of 60 square inches were counted with the template.

The chi-square test of goodness of fit indicated an association between the observed number of neps and the Poisson distribution when counted with or without the template. The fit was better for the data obtained without the template, however, because a larger area (216 square inches compared to 60 square inches) was counted making the observed number of neps larger.

The second series of tests was performed to determine the accuracy of the reproducibility of the results of nep tests using the nep test machine. This series consisted of 5 replicates of each of 6 cottons for which the neps in each of 10 specimens of web were counted by each of two technicians without the use of a template.

The analysis of the results of these tests indicated that there was not any significant difference between the results obtained by the two technicians (Table 2). There was, however, a significant increase in the number of neps per board from board number one to board number 10 as shown below:

Board Number	Neps expressed as percent of board number one
1	100
2	114
3	113
4	112
5	123
6	122
7	125
8	137
9	135
10	138

As pointed out previously, nep data fits the Poisson distribution in which the variance in the results for a large number of replications equals the average number of neps counted in each replication. From this relationship, the accuracy of the reproducibility of the results for various levels of neps as based on nep counting of 10 specimens or 360 square inches was calculated. These values were then adjusted to number of neps per 100 square inches of web as shown below:

Neps per 100 square inches of web	Standard error when 10 specimens are counted
10	$\pm$ 1.7
20	$\pm$ 2.4
30	$\pm$ 2.9
40	$\pm$ 3.3
50	$\pm$ 3.7
60	$\pm$ 4.1

Table 2.--Neps per 100 square inches of web prepared on nep test machine as counted by each of two technicians 1/

Cotton and replication	Neps per 100 square inches of web counted: Tech. 1	Tech. 2	Average
Cotton # 1 (15/16 in.)-			
1	19	20	20
2	21	24	22
3	22	20	21
4	23	25	24
5	16	18	17
Average	20	21	21
Range	7	7	7
Cotton # 2 (1 inch)-			
1	24	21	22
2	15	14	14
3	16	15	16
4	18	16	17
5	18	17	18
Average	18	17	17
Range	9	6	8
Cotton # 3 (1-1/32 in.)-			
1	28	27	28
2	26	27	26
3	32	32	32
4	31	30	30
5	27	24	26
Average	29	28	28
Range	5	8	6
Cotton # 4 (1-1/8 in.)-			
1	63	68	66
2	51	64	58
3	61	55	58
4	52	62	57
5	72	64	68
Average	60	63	61
Range	21	13	11
Cotton # 5 (1-3/16 in.)			
1	24	25	24
2	29	30	30
3	26	28	27
4	21	25	23
5	26	25	26
Average	25	27	26
Range	8	5	7
Cotton # 6 (1-1/2 in.)			
1	28	29	28
2	29	24	26
3	26	24	25
4	29	28	28
5	29	29	29
Average	28	27	27
Range	3	5	4
All Cottons:			
Av. No.	30	31	30
Av. range	8	7	7

1/ Neps on ten 4x9-inch specimen were counted for a total of 360 square inches of web.

Procedure Adopted for Making Nep Tests

Based on the results of the series of tests made on the equipment and method of evaluation, a standard procedure was adopted for routine laboratory tests for determining the nep content of cotton samples as follows:

1. Condition the source sample for at least 4 hours in standard atmospheric conditions of 65 percent relative humidity at 70 degrees F. temperature.
2. Extract a number of small pinches of fiber at random from the source sample to provide a representative 3-gram test sample.
3. Blend the 3-gram test sample on the USDA Mechanical Blender three times.
4. Fold in both edges of the blended sample slightly to reduce its width to approximately 4 inches.
5. Place the bat on the feed apron of the nep test machine and start feeding it between the feed roll and feed plate.
6. Place specimens of the web on ten 4 x 9-inch boards covered with black velvet as the fibers are delivered by the machine.
7. Calculate the number of neps per 100 square inches of web from the average number of neps in the ten web specimens as counted by the two technicians.
8. Strip and clean the machine of all adhering fiber before processing another test sample.
9. Exercise care in handling both the blended bat fed to and the specimen web delivered by the machine to avoid stretching and to assure the desired specimen unit weight equivalent to 40-grain card web.

Two technicians working together can organize this procedure so that there is little lost motion. The blending of the test sample, preparing of the web specimens, counting of the neps, and calculating the results are separate operations. By staggering these operations and alternating them between the technicians, a work load balance can be maintained. In this way, an average of 4 samples per hour can be evaluated for nep content by a team of 2 technicians.

Significance of Nep Test Results

The procedure described above was employed in performing nep tests on the third series of samples which were performed to ascertain the significance of the nep test results. These tests were performed on a total of 498 samples which were grown at various locations during the

1951 and 1952 seasons. A total of 287 cottons were grown commercially 7/ and a total of 211 were grown at State and Federal Agricultural Experiment Stations 8/. These samples include cottons having a wide range of fiber properties, varieties, and growth conditions and were divided into the following groups:

1. 34 short staple cottons on which carded yarn spinning tests had been performed employing a carding rate of 12-1/2 pounds-per-hour.
2. 386 medium staple cottons on which carded yarn spinning tests had been performed employing a carding rate of 9-1/2 pounds-per-hour.
3. 78 long staple cottons on which carded yarn spinning tests had been performed employing a carding rate of 6-1/2 pounds-per-hour.

Nep test data obtained on these three groups of samples by using the nep test machine were compared to the neps in card web and yarn appearance data which had been previously obtained on the same cottons. Simple correlation analyses were employed in making the following comparisons:

1. Relationship of neps per 100 square inches of card web for each of the 3 groups of cottons with neps per 100 square inches of nep test machine web.
2. Relationship of carded yarn appearance index for 3 groups of cotton with neps per 100 square inches of card web.
3. Relationship of carded yarn appearance index for 3 groups of cotton with neps per 100 square inches of nep test machine web.

The simple correlation coefficients ($\bar{r}$) of 0.566, 0.690, and 0.783, for short, medium, and long staple cottons, respectively, indicate that the correlation between neps in card web and neps in nep test machine web is relatively low (Table 3). The variance in neps in card web explained by neps in nep test machine web ($\bar{r}^2$ x 100) ranges from 32 percent for the short staple cottons to 61 percent for the long staple cottons. These results indicate that the relationship is not sufficiently high to permit the use of a conversion formula for routinely reporting the nep test machine results as estimated neps per 100 square inches of card web. The standard error of the estimate ranges from 6.9 neps per 100 square inches for long staple cottons to 9.4 neps per 100 square inches for medium staple cottons.

7/ Summary of Fiber and Spinning Test Results for Some Varieties of Cotton Grown by Selected Cotton Improvement Groups, Crop of 1951; 33 pp., PMA, USDA - February 1952.

8/ Progress Report on the Annual Variety and Environmental Study of Fiber and Spinning Properties of Cottons, 1952 Crop; Agri. Res. Adm., USDA - June 1953.

Table 3.--Statistical results of simple correlation analyses of nep test and yarn appearance data for three groups of cottons, crops of 1951 and 1952

Statistical items and cottons 1/	Number of samples	Statistical results of simple correlation analyses of specified nep test and yarn appearance data 2/		
		Neps in card web with neps in nep test machine web	Yarn appearance with neps in card web	Yarn appearance with neps in nep test machine web
Coefficient of correlation				
Short staple cottons	34	0.566 $\pm$ 0.118	-0.433 $\pm$ 0.141	-0.590 $\pm$ 0.114
Medium staple cottons	386	.690 $\pm$ .027	- .578 $\pm$ .034	- .722 $\pm$ .024
Long staple cottons	78	.783 $\pm$ .044	- .755 $\pm$ .049	- .788 $\pm$ .043
Coefficient of determination				
Short staple cottons	34	0.320	0.187	0.348
Medium staple cottons	386	.476	.334	.521
Long staple cottons	78	.613	.570	.620
Standard error of estimate:				
Short staple cottons	34	$\pm$9.31	$\pm$6.37	$\pm$5.71
Medium staple cottons	386	$\pm$9.42	$\pm$8.31	$\pm$7.05
Long staple cottons	78	$\pm$6.90	$\pm$6.35	$\pm$5.97

1/ Carding rate of 12-$\frac{1}{2}$, 9-$\frac{1}{2}$, and 6-$\frac{1}{2}$ pounds-per-hour were used for short, medium, and long staple cottons respectively.

2/ Neps per 100 square inches of web and yarn appearance index were used in the analyses.

Although the correlation between yarn appearance and neps is not particularily high, it is slightly higher for ginned lint evaluations of neps in the nep machine web than it is for spinning test evaluations of neps in card web. Ginned lint evaluations of neps explained 35 percent of the variance in carded yarn appearance grade as compared with 19 percent explained by spinning test evaluation of neps in card web for short staple cottons. These evaluations also explained 52 percent as compared with 33 percent for medium staple cottons, and 62 percent as compared with 57 percent for long staple cottons.

Other statistical values show this same trend of greater significance for nep test machine evaluations as compared with card web evaluations. The higher correlation values, however, may be attributable to some extent to the conditions under which the evaluations were made. Only one nep machine and the same two technicians were used in making the ginned lint evaluations over a period of several months. However, two commercial cards and several technicians were used in making the card web evaluations over a period of approximately 1-1/2 years.

Comparative Nep Test Results Using Two Machines

The results of the first three series of tests were obtained by using an experimental model of the nep test machine. A redesigned machine which can be reproduced for routine use in cotton testing laboratories has now been completed. The fourth series of tests was performed to provide comparative results obtained with these two units.

The results of these tests indicate that the agreement between the comparative nep test results obtained with the two units is good, although, the results for the redesigned model tend to be slightly higher (Table 4). The number of neps per 100 square inches of web average 19 for the experimental model as compared to an average of 21 for the redesigned model. The range of neps per 100 square inches of web for the 5 replications average 6 for both the experimental and the redesigned models.

Table 4.--Comparative number of neps per 100 square inches of web from each of two nep test machines 1/

Cotton and replication	Neps per 100 square inches of web from: Machine No. 1	Neps per 100 square inches of web from: Machine No. 2	Cotton and replication	Neps per 100 square inches of web from: Machine No. 1	Neps per 100 square inches of web from: Machine No. 2
Cotton #1 (1-1/32")			Cotton #5 (1-1/16")		
1	4	5	1	25	30
2	6	6	2	21	28
3	4	4	3	25	24
4	5	6	4	17	29
5	6	6	5	21	27
Average	5	5	Average	22	28
Range	2	2	Range	7	6
Cotton #2 (1-1/32")			Cotton #6 (1-1/32")		
1	7	7	1	27	33
2	6	10	2	33	27
3	6	11	3	21	33
4	11	10	4	32	36
5	8	8	5	26	35
Average	8	9	Average	28	33
Range	4	4	Range	12	9
Cotton #3 (15/16")			Cotton #7 (1-1/8")		
1	29	29	1	24	23
2	29	31	2	21	29
3	30	32	3	23	23
4	31	28	4	30	27
5	32	31	5	27	27
Average	30	30	Average	25	26
Range	3	4	Range	9	6
Cotton #4 (1-1/8")					
1	12	19	All Cottons		
2	13	11	Average No.	19	21
3	21	19	Average Range	6	6
4	13	16			
5	18	19			
Average	15	17			
Range	6	8			

1/ Experimental model is designated as Machine No. 1 and redesigned model is designated as Machine No. 2.